WISCONSIN DEPARTMENT OF NATURAL RESOURCES

CONSERVATION PRACTICE STANDARD

SITE EVALUATION FOR STORM WATER INFILTRATION

1002

DEFINITION

This standard defines site evaluation procedures to:

(1) Perform an initial screening of a *development site*[1] to determine its suitability for infiltration,

(2) Evaluate each area within a development site that is selected for infiltration, and

(3) Prepare a site evaluation report.

PURPOSE

(1) Protect groundwater from surface water pollution sources,

(2) Identify areas suitable for infiltration,

(3) Establish methods to a) characterize the site, and b) screen for exclusions and exemptions under ch. NR 151, Wis. Adm. Code,

(4) Establish requirements for siting an *infiltration device* and the selection of *design infiltration rates*,

(5) Define requirements for a site evaluation report documenting that appropriate areas are selected for infiltration and that an appropriate design infiltration rate is used, and

CONDITIONS WHERE PRACTICE APPLIES

This standard is intended for development sites being considered for storm water infiltration devices. Additional site location requirements may be imposed by other storm water infiltration device technical standards.

Be aware of applicable federal, state and local laws, rules, regulations or permit requirements governing infiltration devices. This standard does not contain the text of federal, state or local laws. Note that infiltration devices are commonly regulated as plumbing when in connection with a piping system, see ch. SPS 382, Wis. Adm. Code. This technical standard enables state and local authorities to implement infiltration requirements with uniformity.

CRITERIA

The site evaluation consists of four steps (Steps A – D) for locating the optimal areas for infiltration and establishing the design infiltration rate for properly sizing infiltration devices (below, and Figure 1).

To avoid costly redesigns, it is recommended to complete Step A before the preliminary plat, and Step B before the final plat or Certified Survey Map (CSM) is approved. For regional infiltration devices, and for devices constructed on public right-of-ways, public land, or jointly owned land, Step C should be completed before the final plat or final CSM approval.

Infiltration devices distributed around a development will usually better sustain the existing hydrology, and can improve the lifespan of devices, compared to a single *regional device*. Information collected in Step A may be used to explore the potential for multiple *infiltration areas* versus a regional device.

---

[1] Words in the standard that are shown in italics are described in the Definitions section. The words are italicized the first time they are used in the text.

Figures and Attachments:

Record information for Steps B and C as noted in Step D. Prepare a single report for the infiltration evaluation.

Step A. Initial Site Screening

The purpose of Step A is to use existing available information to determine if installation is limited by s. NR 151.124 (3)(a) or (4), Wis. Adm. Code, and where field work is needed for Step B.

A wetland determination or delineation may be needed to identify boundaries of wetlands within or near the site, but is not required as part of the soil evaluation.

The initial screening may be conducted without fieldwork to determine the following:

(See a list of references and resources in the Considerations section).

(1) Site topography and slopes greater than 20%,

(2) Site soil infiltration capacity characteristics as defined in NRCS County soil surveys or other relevant source,

(3) *Soil parent material* obtained from published soil descriptions,

(4) *Hydrologic condition* based on the c*ondition values* for the current and two previous months' rainfall (Attachment 1),

(5) Soil map unit, depth to groundwater and depth to restrictive features; use seasonally high groundwater information where available,

(6) Distance to sites listed on the Wisconsin Remediation and Redevelopment Database (WRRD) sites within 500 feet from the perimeter of the development site,

(7) Known presence of endangered species habitat,

(8) Location of rivers, streams, lakes, and floodplains,

(9) Location of mapped wetlands, hydric soil and potentially hydric soil based on the Wisconsin Wetland Inventory (WWI), which can be accessed via the WDNR Surface Water Data Viewer,

(10) Areas prohibited from installation of storm water infiltration devices by s. NR 151.124(3)(a) and (4)(a), Wis. Adm. Code, including, but not limited to, setbacks from *direct conduits to groundwater* such as wells, sinkholes, and *karst features* due to the potential for groundwater contamination,

(11) Areas exempt from the requirement to install storm water infiltration devices by ss. NR 151.124 (3)(b) and (4)(c) Wis. Adm. Code,

(12) Potential impact to utilities, and

(13) Potential impact to adjacent property.

Step B. Preliminary Field Verification of the Initial Site Screening

The purpose of Step B is to field-verify information from Step A for all potential areas of the development site considered suitable for infiltration. Evaluate the areas for depth to groundwater, depth to *bedrock*, and soil texture to verify any exemption and exclusion found in Step A. *Soil borings* are acceptable for Step B.

Sandy loams, loams, silt loams, silts and all clay textural classifications are assumed to meet the *percent fines* limitations of a filtering layer in s. NR 151.002(14r), Wis. Adm. Code, for both 3 and 5 foot soil layers. *Coarse sand* does not meet s. NR 151.002(14r), Wis. Adm. Code, limitations for a 3 foot soil layer consisting of 20% fines. Other sand textures and loamy sands may require the percent fines level be verified with a sieve analysis.

Step C. Establishment of Design Infiltration Rate

The purpose of Step C is to determine if locations identified for infiltration devices are suitable for infiltration and to provide the required information to design the device.

Test pits are required for Step C. If a backhoe is unable to excavate a test pit to the required depth, then soil borings may be used to evaluate the depth below that which the backhoe is able to reach. It is expected that a medium-sized backhoe can reach at least 15 feet below grade. Information from soil borings and monitoring well logs may supplement data from test pits. Refer to Attachment 2 for a soil and site evaluation form.

Step C.1. Field Evaluation of Specific Infiltration Areas.

Construct the minimum number of test pits for each infiltration device as defined in Table 1. Local agencies may require additional test pits for soil evaluation.

Excavate test pits to a depth of at least 5 feet below the *native soil interface* elevation (Figures 2 – 4) or to a *limiting layer*, such as bedrock or groundwater. If no limiting layer is encountered, continue excavation to 5 feet below the native soil interface even if *perched conditions* are encountered. For example, if the native soil interface of an infiltration device is 8 feet below the *existing grade*, a test pit at least 13 feet deep will be needed (8 feet plus 5 feet).

Follow *OSHA* safety protocol for designing and entering test pits. To avoid entering test pits, soil may also be examined from the surface as it is excavated.

Complete morphological soil profile description using the NRCS Field Book for Describing and Sampling Soils, (latest edition). Soil profile descriptions are to be made by a professional meeting the Qualifications (see Step D). Document the test pits using the Soil Test Pit Evaluation form in Attachment 1.

Table 1. Evaluation Requirements to Proposed Infiltration Devices [Note 1]

Infiltration Device (Technical Standard [Note 2, Note 3])	Tests Required	Minimum Number of Test Pits Required [Note 4, Note 5]
Rain Garden	Soil texture evaluation or infiltration test	N/A
Infiltration Trenches (1007)	Test pits	1 test pit/100 linear feet of trench with a minimum of 2 test pits, and sufficient to determine / confirm variability
Vegetated Swale (1005)	Test pits	1 test pit/ 500 linear feet of swale with a minimum of 2 test pits, and sufficient to determine / confirm variability
Bioretention Systems (1004)	Test pits	1 test pit or a number sufficient to assess infiltration potential, and sufficient to determine / confirm variability
Surface Infiltration Basins (1003)	Test pits	2 test pits then an additional test pit /10,000 square feet and sufficient to determine / confirm variability
Subsurface Dispersal Systems (N/A) greater than 15 feet in width	Test pits	2 test pits then an additional test pit /10,000 square feet and sufficient to determine / confirm variability
Permeable Pavement Systems (1008)	Test pits	2 test pits then an additional test pit /10,000 square feet and sufficient to determine / confirm variability

Note 1 Maintain trench safety requirements; test pit evaluations can be made from the surface without entering the pit.

Note 2 Technical standards refer to the corresponding WDNR design technical standard containing design criteria for this practice.

Note 3 Where initial site borings show uniform soils throughout the site, the professional meeting the Qualifications (see Step D) may reduce the number of test pits, provided information from both test pits and soil borings confirm a uniform soil condition across the proposed device location.

Note 4 Test pits are optimally located within 10 feet of the footprint perimeter, and not within the footprint.

Note 5 If a backhoe is unable to excavate a test pit deep enough from the existing surface to reach 5 feet below the native soil interface, then soil borings may be used to evaluate the depth below the which the backhoe is unable to reach. It is expected that even a medium sized backhoe can reach at least 15 feet below grade.

Step C.2. Infiltration Rate Exemption.

To determine if a site is eligible for exemption from infiltration under s. NR 151.124(4)(c), Wis. Adm. Code, use a scientifically credible field test method unless the least permeable soil horizon within five feet below the native soil interface is one of the following: sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, or clay. Take at least three infiltration tests at the optimal infiltration location per the criteria obtained in Step B, and distribute tests so that they best represent the area being tested (see Step C.3. Infiltration Option 2 for infiltration test methods). Conduct tests within the native soil layer being evaluated for exemption. For a site to be exempt from infiltration requirements, at least two-thirds of tests are to have a measured infiltration rate of less than 0.6 in/hr. Use the infiltration rate from actual field measurements to request an exemption to infiltration requirements; correction factors do not apply.

Step C.3. Infiltration Rate Determination.

The purpose of this step is to determine a design infiltration rate (Infiltration Options 1 – 3).

Use Infiltration Options below to determine the design infiltration rate. Examples calculate the *static infiltration rate.*

Note that *soil compaction mitigation* reduces the soil density and promotes infiltration.

<u>Infiltration Option 1 – Infiltration Rate Not Measured, Soil Compaction Mitigated</u>

Using information from soil test pits, select the design static infiltration rate from Table 2 based on soil texture of the least permeable soil horizon within 5 feet below the native soil interface. See Example 1.

Table 2. Design Static Infiltration Rates for Soil Textures Receiving Storm Water [Note 1]

Soil Texture	Design Static Infiltration Rate Without Measurement (Inches/Hour) [Note 2]
Coarse sand or coarser	3.60
Loamy coarse sand	3.60
Sand	3.60
Loamy sand	1.63
Sandy loam, fine sand, loamy sand, very fine sand, and loamy fine sand	0.50
Loam	0.24
Silt loam	0.13
Sandy clay loam	0.11
Clay loam	0.03
Silty Clay loam	0.04 [Note 3]
Sandy clay	0.04
Silty clay	0.07
Clay	0.07

[Note 1] These infiltration rates are not to be used to request exemption from infiltration requirements.

[Note 2] Infiltration rates represent the lowest value for each textural class presented in Table 2 of Rawls, 1998.

[Note 3] Infiltration rate is an average based on Rawls, 1982 and Clapp & Hornberger, 1978.

Table 2 assumes separation from the native soil interface to a limiting layer such that mounding of water will not reach the native soil interface. A regulatory authority may require a mounding analysis when concerned that mounding may impair the function of the device or have an adverse impact to property. See Considerations section for more information.

Where adverse soil structure is present, such as moderate to strong platy soil structure, compacted or cemented soil horizons, or massive soil conditions with high bulk density reduce the design static infiltration rates per judgment of an individual meeting the Qualifications in Step D.

Example 1.

(1) Calculate the design static infiltration rate (F_{static}) where the native soil interface is 4 feet below existing grade (Table E1).

Table E1. Observed Soil Conditions for Example 1

Soil Depth Below Existing Grade (Inches)	Soil Texture	Infiltration Rate [Note 1] (Inches/Hour)
0 – 12	Silt Loam	0.13
12 – 24	Sandy Loam	0.50
24 – 72	Loam	0.24
72 – 130	Silt Loam	0.13
130 – 180	Loam	0.24

Note 1 Infiltration rates are from Table 2.

Solution 1.

(1) F_{static} = the soil texture with the lowest infiltration rate within 5 feet below the native soil interface

(2) Solve for F_{static}: Add 5 feet to the depth of the native soil interface (4 feet) for a total of 9 feet of depth. The soil texture with the lowest infiltration rate from 4 feet to 9 feet (48 to 108 inches) below existing grade is silt loam, for which Table E1 shows an infiltration rate of 0.13 in/hr.

(3) F_{static} = 0.13 in/hr.

<u>Infiltration Option 2 – Infiltration Rate Measured with In-Field Device, Soil Compaction Mitigated</u>

Conduct two field infiltration tests within each soil test pit at the native soil interface as required in Table 1 and calculate a geometric mean infiltration rate.

Select infiltration measurement location(s) representative of the site being tested. Conduct the infiltration tests at the native soil interface elevation of the proposed infiltration device. If the infiltration rate is measured with a *Double-Ring Infiltrometer*, use the requirements of ASTM D3385 for the field test, except that the test period may be reduced to 2 hours and may be a falling head test (WDNR 2010). Record at least 5 water depth measurements spaced throughout the test period to determine the lowest infiltration rate that occurs during the test. An infiltration test may be conducted over a period of less than 2 hours only if water is depleted during testing due to a high infiltration rate (e.g., > 10 in/hr). In this case, graph the infiltration rate change with respect to time using the measured data points to project the infiltration rate out to 2 hours.

Infiltration testing is used to determine the lowest infiltration rate under a saturated soil condition during **non-frozen soil conditions**. Infiltration test results may not be representative due to macro pores (e.g., soil cracks, worm holes); therefore, avoid areas with macro pores. If cracks in soil are due to dry soil, do not test until soil has taken on adequate moisture to eliminate the soil cracks.

The geometric mean of infiltration test results should be used. However, it may be appropriate to group certain test results where an infiltration trend is apparent and assign different geometric mean rates accordingly. Grouping of results may be done based on soil type or spatial reasons to provide representative results. Where an infiltration rate is too low to measure, a rate of 0.03 in/hr may be used to calculate a geometric mean of the dataset (the dataset's values must be greater than zero to calculate a geometric mean).

To calculate the static infiltration rate,

(1) Determine the ratio of textural infiltration rates (*R*) by dividing the textural infiltration rate (Table 2) at the native soil interface by the lowest textural infiltration rate (Table 2) within 5 feet below the native soil interface.

(2) Use this ratio to select the appropriate correction factor (*A*) from Table 3. The correction factor is based on compaction mitigation occurring, and adjusts the measured infiltration rates for the occurrence of less permeable soil horizons below the surface and the potential variability in the subsurface soil horizons throughout the infiltration site.

(3) Next, divide the geometric mean of the measured infiltration rates by the correction factor (*A*) to obtain the static infiltration rate.

Table 3. Correction Factors for Measured Infiltration Rates at Infiltration Devices [Note 1]

Ratio of Textural Infiltration Rates (*R*)	Correction Factor (*A*)
1	2.5
1.1 to 4.0	3.5
4.1 to 8.0	4.5
8.1 to 16.0	6.5
16.1 or greater	8.5

[Note 1] Washington State Department of Ecology, 2001.

Example 2.

(1) Calculate the static design infiltration rate (F_{static}) for an infiltration device having Double-Ring Infiltrometer measurements with a geometric mean (G) infiltration rate of 1.45 in/hr.

(2) The infiltration device native soil interface is 4 feet (48 inches) below existing grade. No groundwater or redoximorphic features were encountered.

Table E2. Observed Soil Conditions for Example 2

Soil Depth Below Existing Grade (Inches)	Soil Texture	Infiltration Rate [Note 1] (Inches/Hour)
0 – 12	Silt Loam	0.13
12 – 84	Sandy Loam	0.50
84 – 180	Loam	0.24

[Note 1] Infiltration rates are from Table 2.

Solution 2.

(1) Calculate *R*, the ratio of textural infiltration rates = T_N / T_L

Where:

T_N = Textural infiltration rate at the native soil interface (Table 2, sandy loam)

T_L = Lowest textural infiltration rate within 5 feet below the native soil interface (Table 2, loam)

(2) *R* = 0.50 in/hr (sandy loam) / 0.24 in/hr (loam) = 2.08

(3) From Table 3, the correction factor (*A*) for 2.08 is 3.5.

(4) Calculate F_{static}, the static infiltration rate = *G* / *A*

Where:

G = the geometric mean of the measured infiltration rate = 1.45 in/hr

A = the correction factor from Table 3 based on *R*.

(5) F_{static} = 1.45 in/hr / 3.5 = 0.41 in/hr

Infiltration Option 3 – Infiltration Rate Not Measured, Soil Compaction Not Mitigated

Notice: **This section is not applicable where soil compaction mitigation actions will be implemented at an infiltration device (see Definitions).**

Mitigating soil compaction is important, as both topsoil and subsoils can become compacted during construction. It is best to avoid compacting areas, primarily during construction, in the first place, especially areas where infiltration devices will be located. However, construction of an infiltration device can lead to soil compaction, so appropriate actions should be taken to mitigate potential compaction. Soil compaction mitigation actions will vary based on the site and type of infiltration device. Individual infiltration design standards include actions to avoid and mitigate soil compaction. Where actions are not taken to mitigate soil compaction, apply the correction factor (*B*) from Table 4 in this section to further reduce the design infiltration rate of the infiltration device.

Table 4. Static Infiltration Rate Correction Factor for Incidental Soil Compaction Note 1

Compacted Soil Type		**Correction Factor (*B*)**
Sand	Coarse Sand or Coarser	0.9
	Loamy Coarse Sand	
	Sand	
	Loamy Sand	
Loam	Sandy Loam	0.4
	Loam	
	Silt Loam	
	Sandy Clay Loam	
Clay	Clay Loam	0.2
	Silty Clay Loam	
	Sandy Clay	
	Silty Clay	
	Clay	

Example 3.

(1) Calculate the static infiltration rate (F_{static}) where soil compaction mitigation is not performed. Observations from the test pit indicate that the soil texture with the lowest permeability within 5 feet below the native soil interface is sandy loam.

Solution 3:

(1) $F_{static} = T_L * B$

Where:

T_L = Lowest textural infiltration rate (Table 2) within 5 feet below the native soil interface

B = the correction factor from Table 4

(2) F_{static} = 0.5 in/hr (Table 2 for sandy loam) * 0.4 (Table 4 correction factor for sandy loam)

F_{static} = 0.2 in/hr

Note that if a vegetated swale is proposed, a dynamic infiltration rate is used.

$F_{dynamic} = F_{static} * 0.5$

Step D – Soil and Site Evaluation Report

Include the site information required in Steps B and C in the Soil and Site Evaluation Report. Complete the single report prior to the *construction plan* submittal for regulatory approval. Include the following in the report:

(1) The date the information was collected.

(2) A legible site plan/map that is presented on paper that is no less than 8 ½ X 11 inches in size and:

  (a) Is drawn to scale,

  (b) Includes a site location map,

  (c) Include a north arrow,

  (d) Includes a permanent vertical and horizontal reference point,

  (e) Illustrates the entire development site,

  (f) Shows all areas of planned filling and/or cutting if known,

  (g) Shows the percent and direction of land slope for the site or contour lines,

  (h) Highlights areas with slopes over 20%,

  (i) Shows all floodplain information (elevations and locations) that is pertinent to the site,

  (j) Shows the locations of the soil borings and test pits,

  (k) Shows the location by site grid and elevations of existing surface and bottom of all test pits/borings included in the report,

  (l) Shows location of wetlands within the entire development site as field delineated and surveyed,

  (m) Shows location of private wells within 100 feet of the development site, and public wells within 400 feet of the development site, and

  (n) Shows location of karst features within 1,000 feet downgradient and 100 feet upgradient of the development site.

Write soil profile descriptions in accordance with the descriptive procedures, terminology and interpretations found in the Field Book for Describing and Sampling Soils, USDA, NRCS (latest edition). Thaw frozen soil material prior to conducting evaluations for soil color, texture, structure and consistency. In addition to the data determined in Steps B and C, include the following information for each soil horizon or layer of the soil profiles:

(1) Thickness, in inches or decimal feet,

(2) Munsell soil color notation,

(3) Soil mottle or redoximorphic feature color, abundance, size and contrast,

(4) USDA soil textural class with rock fragment modifiers,

(5) Soil structure, grade size and shape,

(6) Soil consistence, root abundance and size,

(7) Soil horizon boundary, distinctness and topography,

(8) Occurrence of saturated soil, groundwater, bedrock or disturbed soil,

(9) Bedrock type, weather-fractured or unfractured, and elevation,

(10) Proposed native soil interface elevation, and

(11) Seasonal and current groundwater elevations.

QUALIFICATIONS

Site Evaluation

Complete Steps A and B by a Licensed Professional with experience in soil investigations, interpretation, and classification acceptable to the authority having jurisdiction.

Soil Evaluation

Complete Step C by a Licensed Professional Soil Scientist, or Licensed Professional Geologist as licensed by the Wisconsin Department of Safety and Professional Services (DSPS) with experience in soil investigations, interpretation, and classification or other licensed professional with 5 years of experience acceptable to the authority having jurisdiction until December 31, 2022.

After January 1, 2023 complete Step C by a Licensed Professional Soil Scientist or Licensed Professional Geologist as licensed by the DSPS.

CONSIDERATIONS

Additional recommendations relating to design that may enhance the use of, or avoid problems with this practice but are not required to insure its function are as follows:

(1) As part of the permitting process, the development site should be checked to determine the potential for *cultural resources*. If cultural resources are known or suspected to be on site, include their location on relevant permit applications.

(2) If a site is suspected of having contaminated soil or other materials from its prior land use, historic fill or other reason, then an evaluation to characterize the potential contamination may be warranted (an Environmental Site Assessment may be justified). New fill should be evaluated for contamination before it is brought to a new site. DNR guidance publications WA-1820 “Waste Soil Determinations and Identifying Clean Soil” (http://dnr.wi.gov/news/input/Guidance.html) and RR-060 “Management of Contaminated Soils and Other Solid Wastes” (http://dnr.wi.gov/files/PDF/pubs/rr/RR060.pdf) were developed to assist generators, regulators and property owners to manage waste properly.

(3) The permitting process requirements for development sites vary across the state and may also vary within a municipality depending on the number of lots being developed. The timing of Steps A, B, and C may need to be adjusted for the type of approval process.

(4) Be aware that any activity that will result in a discharge of fill material to a wetland will require a permit under s. 381.36 Wis. Stats. Wetlands are defined in s 23.32 Wis. States and Ch. NR 103, Wis. Adm. Code.

(5) Resources available for completing Steps A and C:

    (a) USDA-NRCS Web Soil Survey, websoilsurvey.sc.egov.usda.gov/

    (b) Sites listed in the Wisconsin Remediation and Redevelopment Database (WRRD), including GIS tool, http://dnr.wi.gov/topic/Brownfields/WRRD.html

    (c) Floodplain areas as regulated under s. 87.30, Wis. Stats. and chs. NR 30, 31, and 116, Wis. Adm. Code.

    (d) NRCS Climate Analysis for Wetlands Tables (WETS Tables, see Attachment 1), https://www.wcc.nrcs.usda.gov/climate/navigate_wets.html

    (e) Endangered species habitat as shown on National Heritage Inventory County maps, http://dnr.wi.gov/topic/nhi.

    (f) Access points and road setbacks as determined by county or municipal zoning plans.

(g) Existing reports concerning the groundwater and bedrock. Examples include: Publications from USGS, NRCS, Regional Planning Commissions, WDNR, DATCP, WisDOT, UW system or WGNHS.

(h) The Drinking Water and Groundwater pages of the WDNR http://dnr.wi.gov/topic/DrinkingWater/

(i) The Wisconsin Grain Size Database http://wgnhs.uwex.edu/maps/data

(j) WDNR Surface Water Data Viewer http://dnr.wi.gov/topic/surfacewater/swdv/

(k) Occupational Safety and Health Administration www.osha.gov

(l) WDNR's Process to Assess and Model Grass Swales guidance. Steps for "modified" Double Ring infiltrometer test are given within this guidance. http://dnr.wi.gov/topic/stormwater/standards/ms4_modeling.html

(6) If a karst feature is located within the site, a Karst Inventory Form from the Wisconsin Geological and Natural History Survey should be filled out (https://wgnhs.uwex.edu/water-environment/karst-sinkholes/).

(7) Groundwater monitoring wells, constructed as per ch. NR 141, Wis. Adm. Code, can be used to determine the *groundwater level*. GeoProbes may be used for groundwater levels, provided that groundwater levels have reached a steady state condition. Large sites considered for infiltration basins may need to be evaluated for the direction of groundwater flow.

(8) Consider conducting a groundwater mounding analysis to verify that the *highest anticipated groundwater level* does not approach the native soil interface. The infiltration rate into saturated soil in this case may be at or near zero. This standard requires that limiting layers within 5 feet below the native soil interface of an infiltration device be considered in the design infiltration rate. It is also possible for a limiting layer more than 5 feet below the native soil interface to affect an infiltration device where lateral movement is limited. Increased mounding height, and therefore the potential for increased infiltration device drawdown time, are more likely to occur under the following conditions: shallow depth to groundwater or limiting layer, increased infiltration device size, decreased device length/width ratio, the presence of low-hydraulic conductivity material, thin aquifer thickness, and shallow water table gradient. It is also appropriate to conduct a mounding analysis in locations where mounding may impact basements or adjacent property. Refer to http://dnr.wi.gov/topic/stormwater/standards/gw_mounding.html for mounding calculation guidance.

(9) Ch. NR 151, Wis. Adm. Code provides for a maximum area to be dedicated for infiltration depending upon land use. This cap can be voluntarily exceeded.

(10) One or more areas within a development site may be selected for infiltration. A development site with many areas suitable for infiltration is a good candidate for a dispersed approach to infiltration. It may be beneficial to contrast regional devices with onsite devices for sites that receive runoff from one lot or a single source area within a lot, such as rooftop or parking lot.

(11) Consider conducting a soil evaluation to a depth of 15 feet below the existing grade as standard protocol, unless bedrock or groundwater is reached, and deeper if this area will be 'cut,' or lowered, from existing grade

(12) In some situations, adding fill to a location to increase the separation distance between the proposed bottom of an infiltration device and a limiting layer may make a location suitable for infiltration.

(13) The authority having jurisdiction will decide if a proposed alternative infiltration test method is acceptable for new devices and existing swales. Discuss the proposed plan with the authority before detail design.

(14) The Modified Philip Dunne infiltration test is suitable for assessment of required maintenance because accumulation of fine particles limit the infiltration rate in these practices.

(15) Devices located on or near final slopes of ≥20% may be unstable. Consider a slope stability calculation.

(16) No construction sediment should enter the infiltration device. This includes sediment from site grading as well as construction activities. Avoid stockpiling soils and vehicle travel on the infiltration area. If possible, delineate and protect from compaction areas selected for infiltration during grading and construction. This will help to preserve the infiltration rate and extend the life of the device. Where compaction occurs, follow mitigation requirements as outlined in design technical standards.

(17) *Class V injection wells* are not addressed in this document; see http://dnr.wi.gov/topic/wells/uiw.html for details on these types of wells.

(18) In projects which involve piping of storm water, consult plumbing code in ch. SPS 382, Wis. Adm. Code.

(19) Storm water infiltration devices may fail prematurely if there is:

   (a) An inaccurate estimation of the design infiltration rate,

   (b) An inaccurate estimation of the seasonal high water table or bedrock,

   (c) Excessive compacting or sediment loading during construction, or

   (d) No pretreatment for post-development runoff and lack of maintenance.

(20) Consider vegetation species and root depth and their potential to enhance the infiltration rate.

REFERENCES

Ahmed F., and J.S. Gulliver. (2010). Manual for the Modified Philip-Dunne (MPD) Infiltrometer. St. Anthony Falls Laboratory (http://www.safl.umn.edu).

Ahmed, F., J.S. Gulliver, and J.L. Nieber. (2015). Field infiltration measurements in grassed roadside drainage ditches: Spatial and temporal variability. *Journal of Hydrology*, 530:604-611.

ASTM D 3385 – 88, 1988. Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometers.

Ch. NR 30, Wis. Adm. Code

Ch. NR 31, Wis. Adm. Code

Ch. NR 116, Wis. Adm. Code

Ch. NR 103, Wis. Adm. Code

Ch. NR 141, Wis. Adm. Code

Ch. NR 151, Wis. Adm. Code

Ch. NR 811, Wis. Adm. Code (line 71)

Ch. NR 812, Wis. Adm. Code (line 71)

Ch. NR 815, Wis. Adm. Code (line 552)

Ch. SPS 382, Wis. Adm. Code Design, Construction, Installation, Supervision, Maintenance and Inspection of Plumbing.

Clapp, R.W. and G.M., Hornberger. 1978. Empirical equations for some hydraulic properties. Water Resources Research 14:601-604.

Ferguson, B.K., 1994. Storm water Infiltration, CRC Press Inc.

Finnemore, E. J., 1993. Estimation of Ground-Water Mounding Beneath Septic Drain Fields. Groundwater, Vol. 31 No. 6, pp. 884-889.

Finnemore, E.J., 1995. A program to calculate Ground-Water Mound Heights. Groundwater, Vol. 33, No. 1.

Hantush, M. S., 1967. Growth and Decay of Groundwater-Mounds in Response to Uniform Percolation. Water Resources Research, Vol. 3, No. 1, pp. 227-234.

Lowndes, M., 2000. “Infiltration Basins and Trenches” The Wisconsin Storm water Manual, G3691-3.

Munsell Color (Firm), 2010. Munsell soil color charts: with genuine Munsell color chips. Grand Rapids, MI:Munsell Color.

Rawls, W.J., D.L. Brakensiek and K.E. Saxton, 1982. Estimation of Soil Water Properties, Transactions of the American Society of Agricultural Engineers Vol. 25, No. 5 pp. 1316 –1320 and 1328.

Rawls, W.J., Gimenez, and Grossman, R., 1998. Use of Soil Texture, Bulk Density and Slope of Water Retention Curve to Predict Saturated Hydraulic Conductivity, ASAE, Vol. 41(2), pp. 983-988.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

Washington State Department of Ecology, 2001. Storm Water Management Manual for Western Washington, Publication Numbers 99-11 through 99-15.

Wisconsin Department of Natural Resources, Memorandum: Process to Assess and Model Grass Swales for ss. NR 151.13(2) and NR 216.07(6), WIs. Adm. Code, November 24, 2010. http://dnr.wi.gov/topic/stormwater/documents/GrassSwales080424.pdf.

DEFINITIONS

Aquiclude: A geological material through which zero water flow occurs.

Aquitard: Compacted layer of clay, silt or rock that attenuates water flow underground.

Bedrock: A consolidated rock, or weathered in place parent material larger than 2 mm in size and greater than 50 percent of the soil profile.

Bioretention systems: An infiltration device consisting of an excavated area that is back-filled with an engineered soil, covered with a mulch layer or erosion control mat and planted with a diversity of woody and herbaceous vegetation. Storm water directed to the device percolates through the engineered soil, where it is treated by a variety of physical, chemical and biological processes before infiltrating into the *native soil* and/or discharges through an underdrain.

Class V injection well: Any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a subsurface fluid distribution system. Any infiltration device that has a subsurface pipe distribution system is considered to be an injection well. See ch. NR 815, Wis. Adm. Code or http://dnr.wi.gov/topic/Wells?UIW.html for compliance criteria.

Condition value: A value based on NRCS Climate Analysis for Wetlands Tables (WETS Tables) to denote if the month was dry (1), normal (2), or wet (3) compared to the past 20 years of that same month. Using this data, a month is dry when its total rainfall is less than the 30th percentile, wet when its total rainfall exceeds the 70th percentile, and normal when total rainfall is from the 30th to 70th percentile.

Construction plan: A map and/or plan describing the built-out features of an individual lot.

Coarse sand: Soil material that contains 25% or more very coarse and coarse sand, and <50% any other one grade of sand.

Cultural resources: Historic state resources, including archaeological sites (e.g., Indian mounds, rock art, logging camps), burial mounds, historic structures, and submerged resources.

Design infiltration rate: A velocity (in/hr), based on soil structure and texture, at which precipitation or runoff enters and moves into or through soil. The design rate is used to size an infiltration device or system. Rates are selected based on soil texture or in-field infiltration rate measurements with appropriate correction factors. See also: static infiltration rate, dynamic infiltration rate.

Development site: The entire area planned for development, irrespective of how much of the site is disturbed at any one time or intended land use. It can be one lot or multiple lots.

Direct conduits to groundwater: Wells, sinkholes, swallets, fractured bedrock at the surface, mine shafts, non-metallic mines, tile inlets discharging to groundwater, quarries, or depressional groundwater recharge areas over shallow fractured bedrock.

Double-Ring Infiltrometer: A device that directly measures infiltration rates into a soil surface. The Double-Ring Infiltrometer requires a fairly large test pit excavated to depth of the proposed infiltration device and preparation of a soil surface representative of the bottom of the infiltration area.

Dynamic infiltration rate: The infiltration rate accounting for flowing water conditions (multiply static infiltration rate by 0.5), typically used for vegetated swales and filter strips.

*Existing grade: S*lope of the site prior to modification.

Geometric mean: The *n* root of the product of *n* values. For example, the geometric mean of 0.5, 0.65, and 0.71 inches/hour is:

$$\sqrt[3]{0.5\times0.65\times0.71} = \sqrt[3]{0.23075} = 0.61 \text{ inches/hr}$$

High groundwater level: The higher of either the elevation to which the soil is saturated as observed as a free water surface in an unlined hole, or the elevation to which the soil has been seasonally or periodically saturated as indicated by soil color patterns throughout the soil profile.

Highest anticipated groundwater level: The sum of the calculated mounding effects of the discharge and the seasonal *high groundwater level*.

Hydrologic condition: For the purposes of this standard, a hydrologic condition (H) is based on the NRCS Climate Analysis for Wetlands Tables (WETS Tables) and calculated as follows:

$$H = (C_t \text{ x } 3) + (C_{t-1} \text{ x } 2) + (C_{t-2})$$

Where:

C_t = Condition value for month t

Infiltration areas: Areas within a development site that are suitable for installation of an infiltration device.

Infiltration basin: An open impoundment created either by excavation or embankment with a flat densely vegetated floor. It is situated on permeable soils and temporarily stores and allows a designed runoff volume to infiltrate the soil.

Infiltration device: A structure or mechanism engineered to facilitate the entry and movement of precipitation or runoff into or through the soil. Examples of infiltration devices include irrigation systems, rain gardens, infiltration trenches, bioretention systems, infiltration grassed swales, infiltration basins, subsurface dispersal systems and infiltration trenches.

Infiltration trench: An excavated trench that is usually filled with coarse, granular material in which storm water runoff is collected for temporary storage and infiltration. Other materials such as metal pipes and plastic domes are used to maintain the integrity of the trench.

Karst feature: An area or surficial geologic feature subject to bedrock dissolution so that it is likely to provide a conduit to groundwater, and may include caves, enlarged fractures, mine features, exposed bedrock surfaces, sinkholes, springs, seeps, or swallets.

Licensed Professional Hydrogeologist: A hydrogeologist licensed by the Wisconsin Department of Safety and Professional Services.

Licensed Professional Soil Scientist: A soil scientist licensed by the Wisconsin Department of Safety and Professional Services.

Limiting layer: A limiting layer can be bedrock, an *aquitard*, *aquiclude* or the seasonal high groundwater table, but it does not include a perched water layer (water above an aquitard) or soil with redoximorphic features. A clayey soil aquitard may exist within a few feet below grade, but still have a suitable layer for infiltration within 5 feet below the *proposed grade*.

Native soil interface: The surface at which storm water runoff is proposed to infiltrate. This surface is below an engineered soil layer (see Figures 2-4).

OSHA: Occupational Safety and Health Administration, a government agency to assure safe and healthy working conditions for working men and women (www.osha.gov).

Percent fines: Percentage of given sample of soil which passes through a #200 sieve.

Perched conditions: A soil moisture regime where saturated soil (i.e., wet soil) is located above unsaturated soil (i.e., moist soil).

Permeable pavement system: A pavement system that allows movement of storm water through the pavement surface and into a base/subbase reservoir designed to achieve water quality and quantity benefits.

Proposed grade: The proposed final design elevation and grade of the development. This is the top of topsoil, walkways, planting beds, roads, and parking areas.

Rain garden: A shallow, vegetated depression that captures storm water runoff and allows it to infiltrate.

Regional device: An infiltration system that receives and stores storm water runoff from multiple structures. Infiltration basins are the most commonly used regional infiltration devices.

Soil borings: For the purposes of this standard, soil borings are drilled, bored, cored or dug holes in the ground to obtain data from an unmixed soil sample, such as from a hollow stem auger or split spoon sampler. Mixed soil samples, such as those from a power auger, are not acceptable.

Soil compaction: An increase in bulk density of the soil. The more pressure per unit area exerted on soil, the greater the increase in bulk density, which leads to a decrease in infiltration. Also known as “soil structure degradation.”

Soil compaction mitigation: Taking action to decrease bulk density of the soil, which might be accomplished by a combination of mechanical, vegetative and/or chemical means. Example of compaction mitigation include: deep tilling, deep ripping, soil amendment and establishment of deep-rooted vegetation.

Soil parent material: The unconsolidated material, mineral or organic, from which the *solum* develops.

Solum: The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons.

Static infiltration rate: Infiltration rate as measured for standing water.

Subsurface dispersal system: An exfiltration system that is designed to discharge storm water through piping below the ground surface, but above the seasonal high groundwater table (subject to the applicable requirements of ch. NR 815, Wis. Adm. Code).

Test pit: An excavation, typically using a backhoe, to examine soil composition, texture, steady state and seasonal high groundwater levels, and bedrock proximity.

Vegetated swale: A constructed storm water conveyance system designed to achieve water quality and quantity benefits.

Figure 1:

Site Evaluation for Infiltration Flow Chart

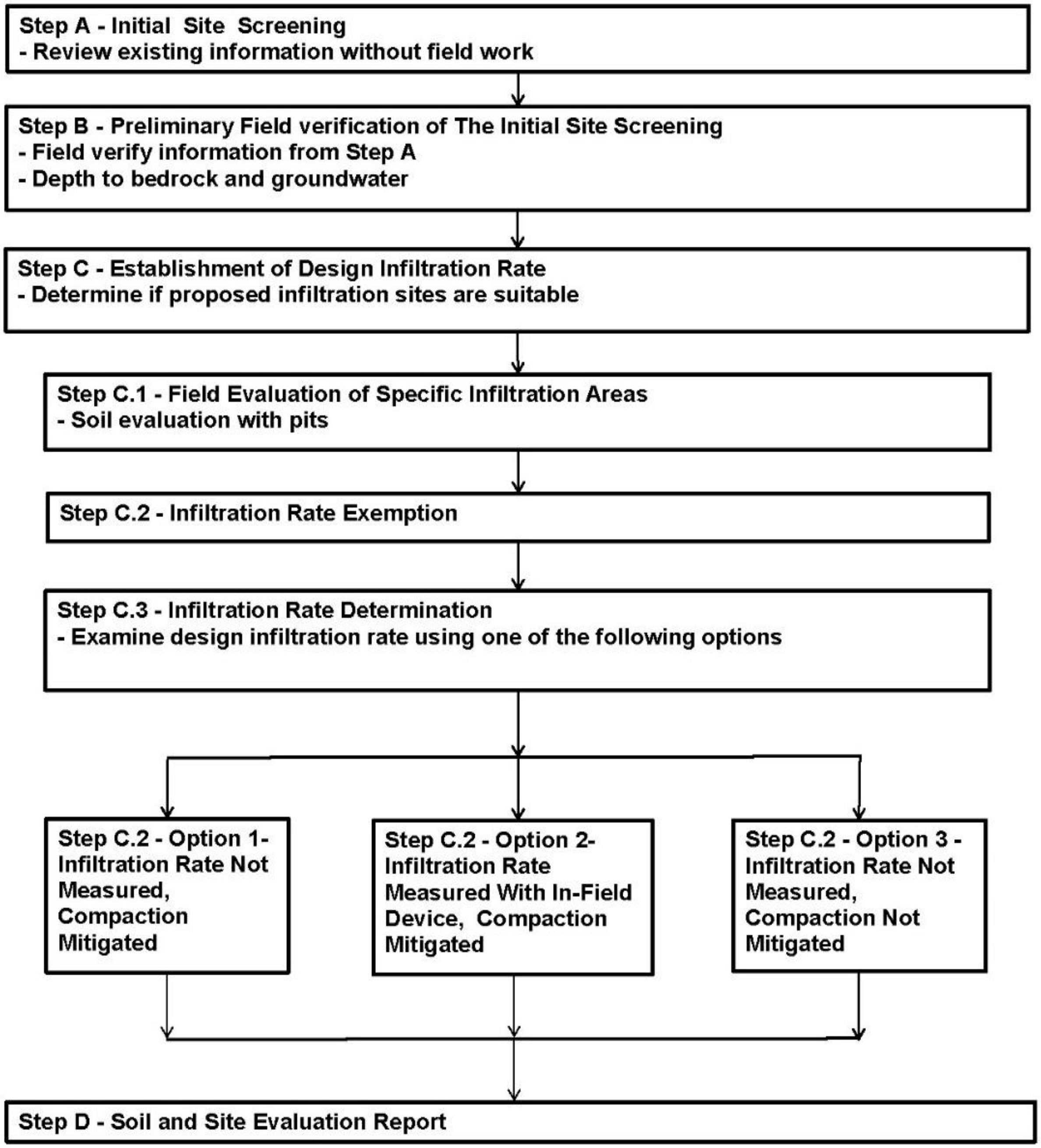
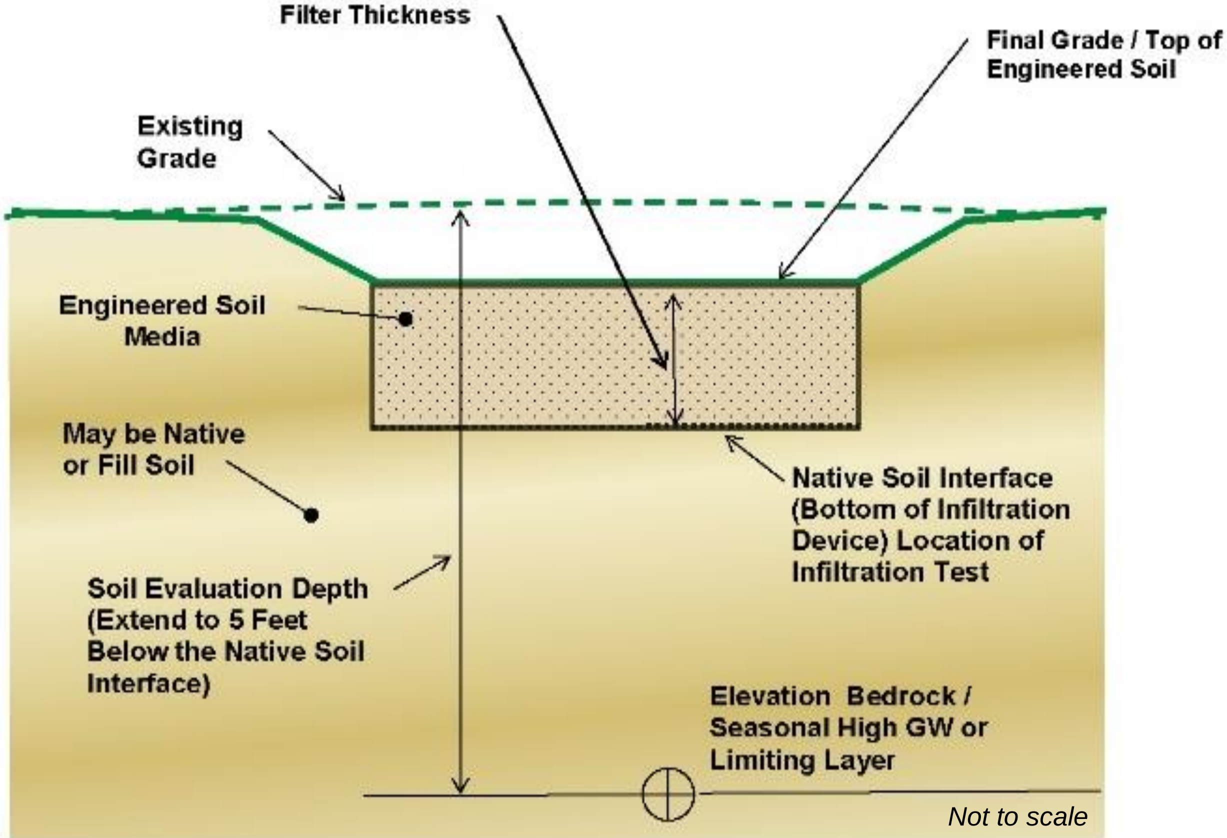


Figure 2:

Example Bioretention Basin Section



Note 1 NR 151 and SPS 382 require a minimum separation distance from the native soil interface and seasonal high groundwater/bedrock.

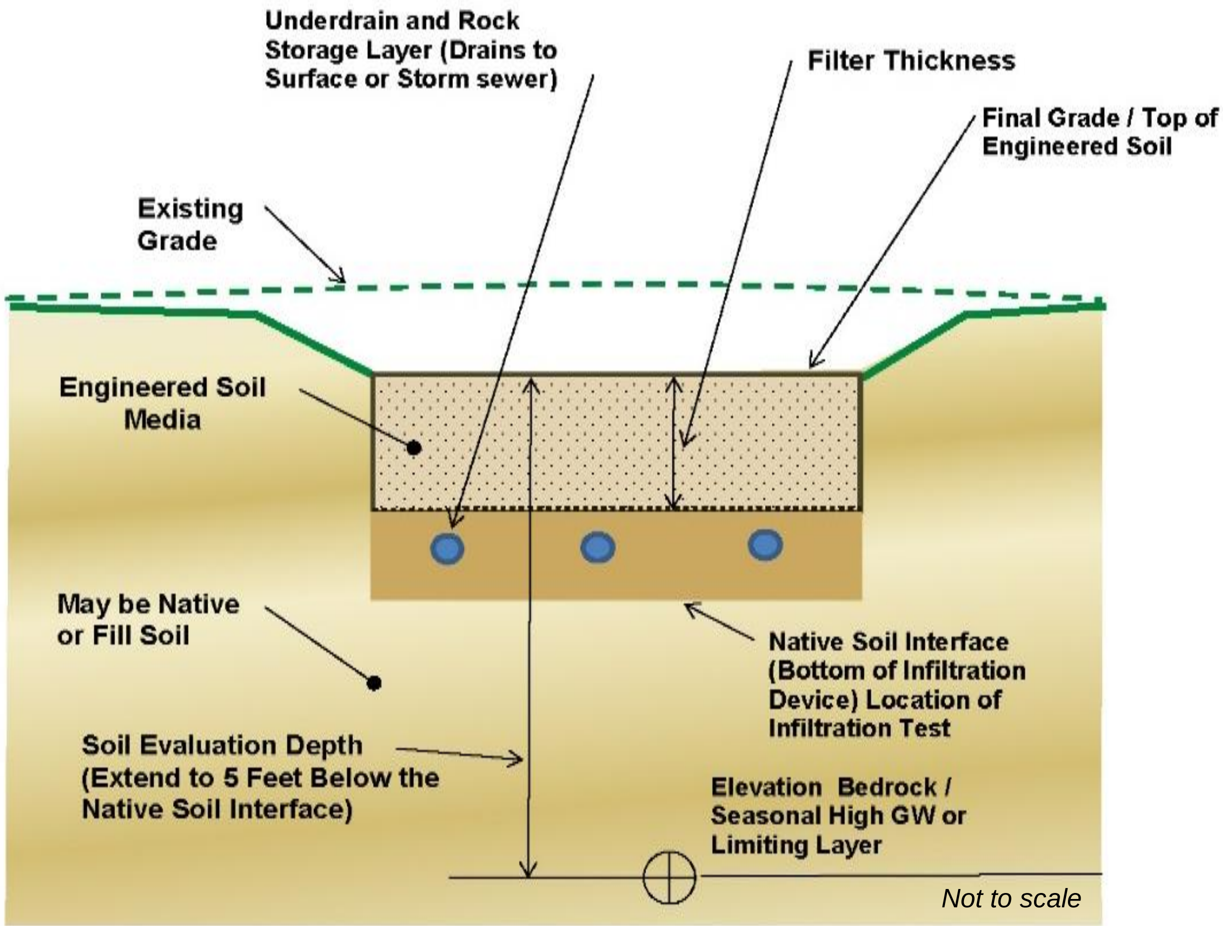
Note 2 Soil evaluation depth shall extend at least 5 feet below the native soil interface, unless seasonal high groundwater or bedrock is reached.

Note 3 Refer to Technical Standard 1004 Bioretention for Infiltration for additional design details.

Note 4 Location of infiltration testing is at the native soil interface.

Figure 3:

Example Bioretention Basin with Underdrain Section



Note 1 NR 151 and SPS 382 require a minimum separation distance from the native soil interface and seasonal high groundwater/bedrock.

Note 2 Soil evaluation depth shall extend at least 5 feet below the native soil interface, unless seasonal high groundwater or bedrock is reached.

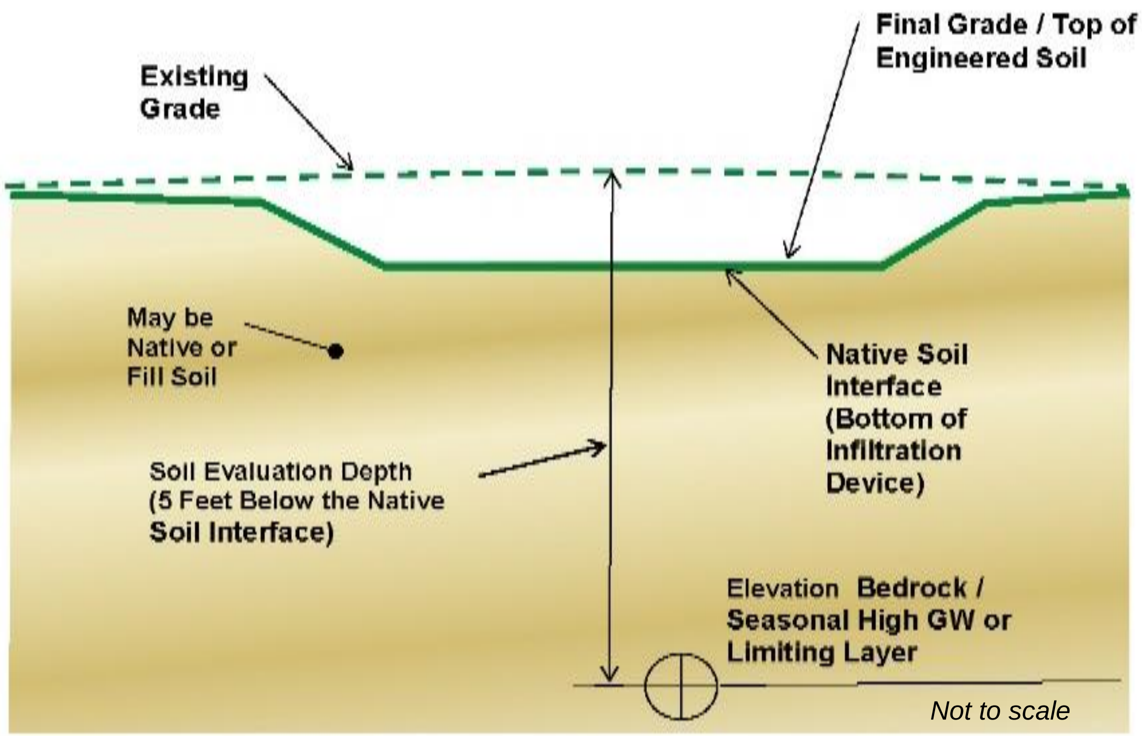
Note 3 Refer to Technical Standard 1004 Bioretention for Infiltration for additional design details.

Note 4 Underdrain and rock storage is not part of filter layer.

Note 5 Location of infiltration testing is at the native soil interface.

Figure 4:

Example Infiltration Basin Section



Note 1 NR 151 and SPS 382 require a minimum separation distance from the native soil interface and seasonal high groundwater/bedrock.

Note 2 Soil evaluation depth shall extend at least 5 feet below the native soil interface, unless seasonal high groundwater or bedrock is reached.

Note 3 Soil amendment, such as compost, may be tilled into the top 1-2 feet of soil.

Note 4 Refer to Technical Standard 1003 Infiltration Basin for additional design details.

Note 5 Location of infiltration testing is at the native soil interface.

Attachment 1:

Hydrologic Condition Form. This optional table may be used to calculate the hydrologic condition to fulfil Step A.(4). See next page for example.

Month	30% chance will have		Average Monthly Rainfall	Current Year Rainfall	Condition Note 1	Condition Value Note 2	Weight Value Note 5	Product of Condition Value and Weight Value
	Less than	More than						
(current)								
(current – 1)								
(current – 2)								
							SUM: Note 5	

[Note 1] Condition:
Where “Current Year Rainfall” < “30% Chance Will Have Less Than,” Condition is *Dry*
Where “Current Year Rainfall” > “30% Chance Will Have More Than,” Condition is *Wet*
Where neither of the above statements (Dry, Wet) is true, Condition is *Normal*

[Note 2] Condition Value:
Where Condition is Dry, Condition Value is *1*
Where Condition is Normal, Condition Value is 2
Where Condition is Wet, Condition Value is *3*

[Note 3] Given numbers.

[Note 4] **Where the sum is 6 to 9**, the hydrologic condition is *drier than normal*. Ensure the infiltration test site is thoroughly pre-wetted prior to conducting infiltration tests, and consider postponing infiltration tests until *normal* or *wetter than norma*l conditions occur. Testing during drier than normal conditions may produce misleading results that may ultimately compromise the integrity of the device.

Where the sum is 10 to 14, the hydrologic condition is *normal*. Infiltration testing during these conditions is recommended.

Where the sum is 15 to 18, the hydrologic condition is *wetter than norma*l. Infiltration testing during these conditions is acceptable.

Hydrologic condition Example. The following information demonstrates how to obtain and use information to calculate hydrologic condition using WETS tables. Refer to https://www.wcc.nrcs.usda.gov/climate/wets_defs.html for more information on WETS tables, examples, and definitions, and to https://www.wcc.nrcs.usda.gov/climate/navigate_wets.html for navigating to climate data, including WETS tables.

This example is for Dane County, Charmany Farm, May 2017, using data from 1997-2017; data from USDA Agricultural Applied Climate Information System (AgACIS) is on the following page.

Month	30% chance will have Note 1		Average Monthly Rainfall Note 1	Current Year Rainfall Note 2	Condition Note 3	Condition Value Note 4	Weight Value Note 5	Product of Condition Value and Weight Value
	Less than	More than						
(current) MAY	3.53	5.42	4.65	3.79	Normal	2	3	6
(current – 1) April	3.02	5.18	4.36	4.21	Normal	2	2	4
(current – 2) March	1.51	3.01	2.49	3.15	Wet	3	1	3
							SUM: Note 6	11 (*Normal*)

`Note 1 Information obtained from WETS tables. Navigate to USDA climate data (see link above), and select (1) Location » nearest the site, (2) Product » WETS, (3) Options » Year Range: past 20 years, Thresholds: 24, 28, 32, (4) View » Go.

Note 2 Information obtained from monthly climate summaries. Navigate to USDA climate data (see link above), and select (1) Location » nearest the site, (2) Product » Monthly summarized data, (3) Options » Year Range: current year; Variable: Precipitation; Summary: Sum; Allowable missing days: 1, (4) View » Go.

Note 3 Condition:
Where “Current Year Rainfall” < “30% Chance Will Have Less Than,” Condition is *Dry*
Where “Current Year Rainfall” > “30% Chance Will Have More Than,” Condition is *Wet*
Where neither of the above statements (Dry, Wet) is true, Condition is *Normal*

Note 4 Condition Value:
Where Condition is Dry, Condition Value is *1*
Where Condition is Normal, Condition Value is 2
Where Condition is Wet, Condition Value is *3*

Note 5 Given numbers.

Note 6 **Where the sum is 6 to 9**, the hydrologic condition is *drier than normal*. Ensure the infiltration test site is thoroughly pre-wetted prior to conducting infiltration tests, and consider postponing infiltration tests until *normal* or *wetter than norma*l conditions occur. Testing during drier than normal conditions may produce misleading results that may ultimately compromise the integrity of the device.

Where the sum is 10 to 14, the hydrologic condition is *normal*. Infiltration testing during these conditions is recommended.

Where the sum is 15 to 18, the hydrologic condition is *wetter than norma*l. Infiltration testing during these conditions is acceptable.

(A)

WETS Station: CHARMANY FARM, WI								
Requested years: 1997 - 2017								
Month	Avg Max Temp	Avg Min Temp	Avg Mean Temp	Avg Precip	30% chance precip less than	30% chance precip more than	Avg number days precip 0.10 or more	Avg Snowfall
Jan	26.9	11.8	19.3	1.49	0.95	1.80	4	9.1
Feb	31.5	15.6	23.6	1.78	1.23	2.11	5	10.5
Mar	43.2	25.2	34.2	2.49	1.51	3.01	5	5.1
Apr	57.4	36.8	47.1	4.36	3.02	5.18	7	1.1
May	68.5	48.3	58.4	4.65	3.53	5.42	9	0.0
Jun	77.8	58.4	68.1	5.36	3.27	6.49	8	-
Jul	82.1	63.0	72.5	4.25	2.75	5.11	6	-
Aug	-	-	-	4.19	2.45	5.09	7	-
Sep	73.6	53.0	63.3	3.29	2.30	3.91	5	-
Oct	60.2	41.0	50.6	2.62	1.70	3.15	5	0.1
Nov	46.8	-	-	2.26	1.30	2.75	4	1.1
Dec	31.5	17.6	24.6	2.28	1.41	2.76	5	11.9
Annual:					35.11	41.63		
Average	-	-	-	-	-	-	-	-
Total	-	-	-	39.01			71	-

GROWING SEASON DATES			
Years with missing data:	24 deg = 2	28 deg = 2	32 deg = 2
Years with no occurrence:	24 deg = 0	28 deg = 0	32 deg = 0
Data years used:	24 deg = 19	28 deg = 19	32 deg = 19
Probability	24 F or higher	28 F or higher	32 F or higher
50 percent *	Insufficient data	Insufficient data	Insufficient data
70 percent *	Insufficient data	Insufficient data	Insufficient data
* Percent chance of the growing season occurring between the Beginning and Ending dates.			

(B)

Monthly Total Precipitation for CHARMANY FARM, WI

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2017	2.75	1.61	3.15	4.21	3.79	6.00	10.89	M	M	M	M	M	M
Mean	2.75	1.61	3.15	4.21	3.79	6.00	10.89	M	M	M	M	M	M

(A) WETS table and (B) current year monthly rainfall output from USDA Agricultural Applied Climate Information System (AgACIS) for use in hydrological determination example, previous page. Data used in the hydrologic condition form is outlined in red. Dates are circled in blue.

1002-CPS-23

Division of Industry Services
P. O. Box 2658
Madison, Wisconsin 53701
Scott Walker, Governor
Laura Gutierrez, Secretary

Attachment 2:

SOIL AND SITE EVALUATION – STORM

In accordance with SPS 382.365, 385, Wis. Adm. Code, and WDNR Standard 1002

Attach a complete site plan on paper not less than 8 ½ x 11 inches in size. Plan must include, but not limited to: vertical and horizontal reference point (BM), direction and percent of slope, scale or dimensions, north arrow, and BM referenced to nearest road ***Please print all information*** Personal information you provide may be used for secondary purposes [Privacy Law, s. 15.04(1)(m)]	County Parcel I.D. Reviewed by: Date:
Property Owner	Property Location Govt. Lot ¼ ¼ S T N R E (or) W
Property Owner' Mail Address	Lot # / Block # / Subd. Name or CSM #
City State Zip Code Phone Number	☐ City ☐ Village ☐ Town Nearest Road

Drainage area ______________ ☐ sq .ft ☐ acres

Test site suitable for (check all that apply): ☐ Site not suitable;

☐ Bioretention; ☐ Subsurface Dispersal System;

☐ Reuse; ☐ Irrigation; ☐ Other _______________

Hydraulic Application Test Method

☐ Morphological Evaluation
☐ Double Ring Infiltrometer
☐ Other: (specify) ____________________

Soil Moisture
Date of soil borings: __________

USDA-NRCS WETS Value:
☐ Dry =1;
☐Normal = 2;
☐ Wet = 3.

☐ #OBS. ☐ Pit ☐ Boring Ground surface elevation. __________ ft. Elevation of limiting factor __________ ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate Inches/Hr

Comments:

☐ #OBS. ☐ Pit ☐ Boring Ground surface elevation. __________ ft. Elevation of limiting factor __________ ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate Inches/Hr

Comments:

Name (Please Print)	Signature	Credential Number
Address	Date Evaluation Conducted	Telephone Number

SBD-10793 (R01/17)

WDNR
September 2017

☐ #OBS. ☐ Pit ☐ Boring Ground surface elevation. __________ ft. Elevation of limiting factor __________ ft. Page ___ of ____

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate Inches/Hr

Comments:

☐ #OBS. ☐ Pit ☐ Boring Ground surface elevation. __________ ft. Elevation of limiting factor __________ ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate Inches/Hr

Comments:

☐ #OBS. ☐ Pit ☐ Boring Ground surface elevation. __________ ft. Elevation of limiting factor __________ ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate Inches/Hr

Comments:

☐ #OBS. ☐ Pit ☐ Boring Ground surface elevation. __________ ft. Elevation of limiting factor __________ ft.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frags.	% Fines	Hydraulic App Rate Inches/Hr

Comments:

Overall Site Comments: